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FINAL REPORT

NEW ATMOSPHERIC SENSOR ANALYSIS STUDY

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Prepared for:
National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

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FOREWORD

This final report provides a summary of the tasks performed on Contract NAS8-36179 for the Earth Sciences and Applications Division (ESAD) of the George C. Marshall Space Flight Center (MSFC).

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1. BACKGROUND

New Technology, Inc. (NTI) began the 30-month effort as a continuation of Contract NAS8-35189. The primary goal of this effort was to extend the functional capabilities of the ESAD (previously known as the Atmospheric Sciences Division) Research Computing Facility. This system is used in processing atmospheric measurements which are utilized in the evaluation of sensor performance, conducting design-concept simulation studies, and also in modeling the physical and dynamical nature of atmospheric processes. These results may then be evaluated to furnish inputs into the final design specifications for new space sensors intended for future Spacelab, Space Station, and free-flying missions. In addition, data gathered from these missions may subsequently be analyzed to provide a better understanding of the requirements for numerical modeling of atmospheric phenomena.

The following study tasks were proposed in order to both enhance and extend computational capabilities of computing resources used by ESAD personnel.

1.1 Data Management System

Vast quantities of data must be examined in order to perform research of atmospheric phenomena. These data sources include conventional satellite images, FAA 604 text data, Kavouras radar, doppler radar, lightning location and protection (LLP), and satellite sensors, as well as that created by numerical models.

It is therefore critical that the data be managed in such a manner as to permit timely catalog interrogation and data retrieval functions for data of interest to the research scientist. Initially this task was intended to concentrate on the Perkin-Elmer system and its resident datasets. However, two things caused this effort to be extended substantially. The first was the involvement of ESAD in the Common Huntsville Meteorological Experiment (COHMEX), which occurred during the summer of 1986. This project generated a tremendous amount of data.

The second factor was the availability of the MASSTOR device on the Engineering and Data Analysis Systems (EADS) which provides pseudo-online access up to approximately 165 Gb of storage. This device is of particular importance since EADS is designed to support minimal tape interaction. The capability to read MASSTOR datasets directly is far better than having to mount and read individual tapes. However, the increased data load from COHMEX combined with the use of MASSTOR datasets instead of tape required a data management scheme to be of critical importance. A survey of data was conducted throughout the division and a

preliminary naming convention for MASSTOR datasets was derived. Numerous data base systems were considered and currently ORACLE appears to be a very promising candidate to host this system.

In addition, experiments were conducted to permit McIDAS commands to interact and examine with the MASSTOR catalog. Generic unpacking routines were derived so that data received from external sources could be converted and loaded into the EADS/McIDAS system. A method of generating McIDAS MD files from raw lightning data tapes was also developed.

1.2 NCAR Graphics

NCAR graphics capabilities were enhanced on the Concurrent 3200 MPS system. The meta-code translators which convert generic meta-code (generated by ESAD models) to displayable graphics were updated to support Apple workstations and McIDAS images. A direct access capability was also developed for the Tektronix version of the code.

1.3 Doppler Radar/Lidar

A software package to facilitate Next-Generation Weather Radar (NEXRAD) processing was installed on the Perkin-Elmer system. This software interacts with a Chromatics color workstation.

Extensive doppler radar data were collected during the COHMEX project and a study was done to determine if these data could be processed using NEXRAD software. Doppler radar data from the FL-2 site (near the Huntsville-Madison County Jetport) were used as a test case. These data, however, were incompatible with the universal data ingestor portion of NEXRAD, therefore, an update to the NEXRAD software was required.

The capability to overlay Alabama maps and lightning stroke data on the NEXRAD displays was also developed. A "quick-look" directory of all radar data collected during the COHMEX project was prepared.

In Spring 1986, a Kavouras radar ingestor box was integrated into the EADS/McIDAS environment on the IBM 4381. This device permits a McIDAS user to schedule requests to receive NWS radar images at a specified time interval from a list of radar sites. The McIDAS host software interacts with the Kavouras

ingestor box to provide schedule information and a sublist of telephone numbers of the requested sites. The Kavouras then uses its own processors to determine the proper time to ingest the next image and to issue the telephone call to the site, receive the image, store it on hard disk, and dump results to the host IBM 4381.

The Kavouras device was used to collect data during the COHMEX field project of 1986. The data were superimposed on current satellite images along with lightning stroke data to determine an accurate representation of the weather conditions.

1.4 Image Processing

Several image processing algorithms were installed on McIDAS on the IBM 4381 system. These algorithms included a bicubic interpolation filter, two-dimensional gradient and low-pass filters, and an edge preserving filter. The bicubic interpolation filter provides a blowup of a region of interest with minimal blurring of the edges of the newly created image.

It was determined that McIDAS images could be loaded onto the International Imaging System (IIS) workstation for subsequent manipulation using IIS routines. Experimentation was successfully performed with McIDAS satellite images. The IIS offers substantial image processing capabilities over the McIDAS core system.

1.5 Prototype Development

Two major areas of concentration in the prototype development effort were the patch panel and PC-based McIDAS. Others included integration of McIDAS ingestors into the LAN, upgrading the AMASS system development of an aircraft beacon tracking device, and building porototype data collection devices for lightning research.

1.5.1 Patch Panel

The patch panel was originally designed to give a scientist the capability to manually switch workstations between various host computers such as HP-1000F, PE, and Harris/6. As MSFC introduced the Hyperbus Local Area Network and Bus Interface Unit (BIU) to access the central computer complex (EADS), the patch panel configuration was modified to take advantage of the automatic switching capability of the BIU's. The existence of the patch panel made the introduction of the LAN easier for ED41 division. The detailed configuration is kept in the data base using dBASE III Plus software. The cabling diagram is depicted in Figure 1.

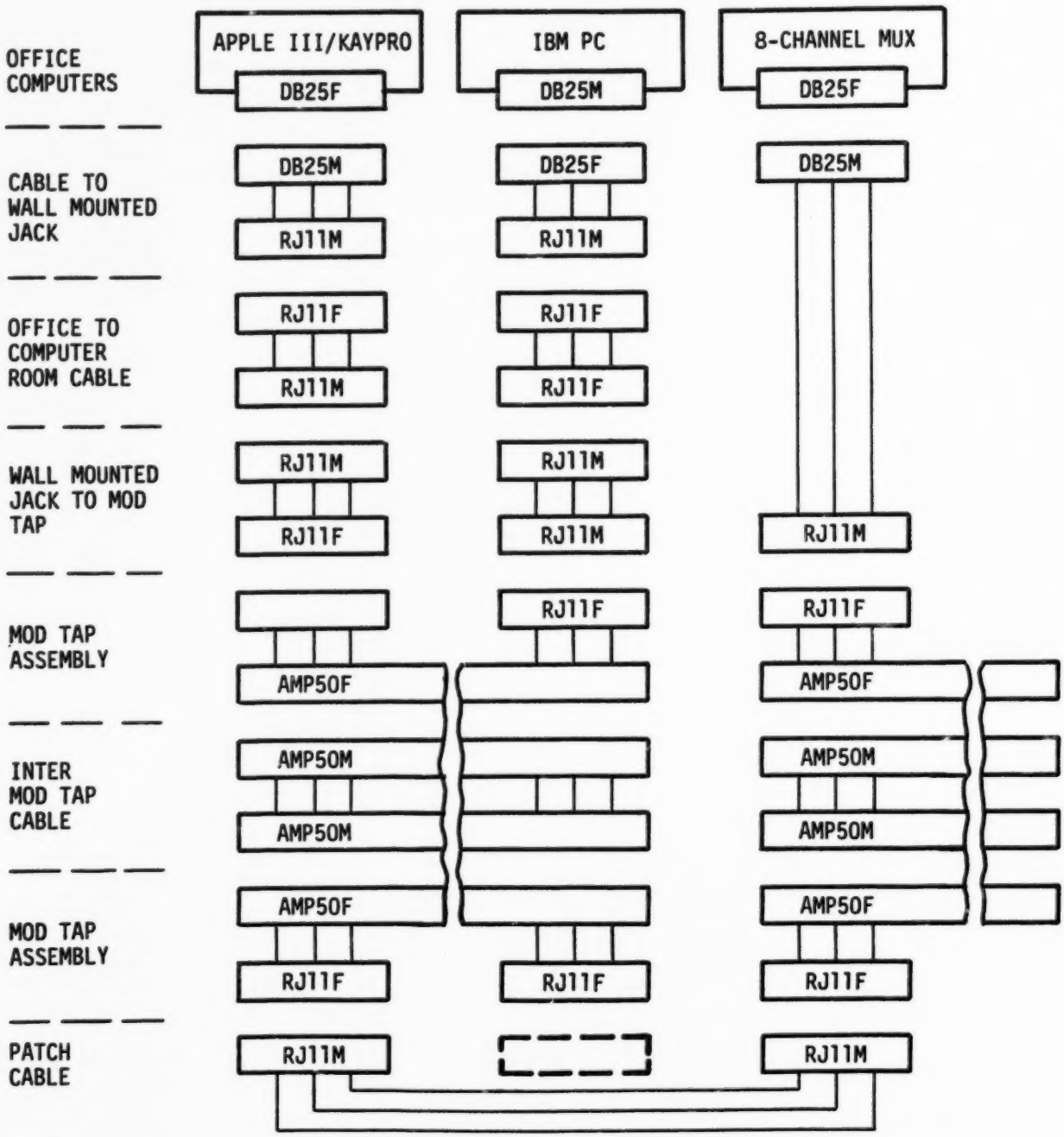

Figure 1. Patch Panel Cabling Diagram

Items procured for the patch panel include the following:

DD 250	Item	Amount
NTI 003	Supplies	$ 550.97
NTI 006	HP Manual 91750-90011	25.00
NTI 005	HP Manual D5/1000IV	17.00
	Apple Access III	82.90
	Reflections Terminal Emulator for IBM/PC	405.00
NTI 004	Supplies	834.61
NTI 010	CBL HP21MX with 12845B	199.82
	4 Dev Line T/S (2)	444.42
	25-ft Cable with MF Nonshield	54.60
	Supplies	917.60

1.5.2 PC-McIDAS

The PC-McIDAS is designed to run on IBM-AT and PS/2 computers under the DOS 3.3 operating system. A number of IBM AT clones have been tested and successfully used as PC-McIDAS workstations. The PC-McIDAS system depends upon data ingestion from the MSFC EADS mainframe McIDAS. The PC-McIDAS systems are connected asynchronously to EADS McIDAS via the IBM 3708 Network Conversion Unit (3708). The 3708's offer up to seven bus interface unit (BIU) ports over the Hyperbus local area network. Each BIU port is set for 9600 BPS asynchronous communication. The host system is connected to 3708's synchronously at the speed of 19.2 KBPS.

The following items were purchased for this effort:

DD 250	Item	Cost
NTI 009	IBM Mono Display (2)	$ 537.50
NTI 008	IBM Network Conversion Unit (No. 1335)	3,824.00
	AME II M/F (2)	56.46
	SME 4M Sync Modem Eliminator	255.00
	P/CAT Modem, Cable Matches, IBM PC 20' MM	168.24
NTI 020	IBM Network Conversion Unit (2), Serial 8814, 8381	5,760.00
NTI 007	4-Dev 25-Line T/S Model 1873	233.49

DD 250	Item	Cost
NTI 039	4-Dev INMAC X-MAT 25-Pin Serial	159.20
NTI 038	Microsoft Pascal Compiler	175.00
	Turbo Tutor 2.0	21.00
NTI 037	FANSI Console	75.00
NTI 035	Microsoft Window	309.00
NTI 033	Blaise Turbo Async Plus	79.00
	Blaise Turbo Power Tools	79.00
	Aldebaron Lab Source Print	89.00
NTI 031	Microport System V/AT Software	359.00
NTI 030	AST Rampage AT with 512 KB	359.95
	White Crane "Brooklyn Bridge"	99.95
	White Crane "Brooklyn Bridge" Model 559	109.95
NTI 028	AST Rampatio-S	195.00
	Memory 256K Update Set (10)	290.00
	Super Calc 4	309.00
NTI 027	Turbo C Compiler	59.00
NTI 019	Memory Boards w/3 MB RAM (8)	5,560.00
NTI 041	IBM Graphics 1501203	168.00
	IBM Monochrome Display 154900	162.00
NTI 018	Rampatio-S 500265-005	144.00
NTI 017	Hercules Graphics Card Plus	199.95
NTI 015	Microway 287 Turbo 10 Math Co-Processor	450.00
NTI 016	IBM-AT 16 MHz Crystal (10)	20.00
NTI 014	Microsoft C with Source Debugger 4.0	279.99
	Turbo Editor Tool Box	41.00
	Turbo Lightning	59.00
NTI 012	Rampage AT with 2 MB	1,499.00
	IBM Mouse with PC Paint Brush Bus	111.05

1.5.3 AMASS Optimization

The following items were purchased to improve performance of the AMASS system:

DD 250	Item	Cost
NTI 001	Qualta Board 4-Line Comm Mux	$ 681.00
NTI 004	Interchange Library (Subroutine Package)	25.00
NTI 011	IOS Switch Panel (M48-063)	609.50
	IOS Panel 3X2	647.80
	Selector Channel	1,380.00

1.5.4 Aircraft Beacon Tracking

The following items were purchased to build a prototype aircraft beacon tracking device for use during COHMEX:

DD 250	Item	Cost
NTI 011	MDB-48-013-01-WW1	$ 798.75
	WDTX78029 TR1863AL04 (5)	139.85
	SN745225N (5)	40.48

1.5.5 Local Area Network

The following items were purchased to connect McIDAS ingestors to the Local Area Network:

DD 250	Item	Cost
NTI 040	ME204 AME-II M/F (2)	$ 55.00
	ME 205 AME-II M/M	27.50
	ME 206 AME-II F/F	27.50
NTI 012	IBM Network Adapter (No. 1704)	4,110.80
NTI 029	GA27-3766 Plan and Inst. Manual (2)	29.00
	GA27-3768 Desc. Manual (2)	44.50
	GA27-3767 Problem Determination (2)	19.80
	GA27-3765 User Reference (2)	18.40
NTI 032	NEC Multispeed	1,228.00
	NEC 300/1200 Modem	246.00
	NEC Carrying Case	61.00
	IBM 3.5" Ext Disc Drive for AT	316.00

1.5.6 Supplies

DD 250	Item	Cost
NTI 023	Tektronix paper (2)	$ 50.00
	Transparencies Hardcopy	90.00
NTI 004	Type 891 8x10 Transparency Film	276.00

1.5.7 Prototype Development - Lightning Research

The following items were purchased for use in building prototype data collection devices for lightning research:

DD 250	Item	Cost
NTI 036	Bi-Sync Adapter	$ 156.00
NTI 021	IBM PC-AT SC50 Interface	225.00
	PCSCSI Software Package	495.00
NTI 034	UDS 201B Modem	593.00
NTI 022	FUJI 8 MM Video Cartridge (2)	33.90
NTI 026	2716 E-PROM National Semiconductor (5)	24.75
NTI 025	20-Pin Wire Wrap Socket (12)	17.88
	16-Pin Wire Wrap Socket (15)	16.35
	14-Pin Wire Wrap Socket	24.75

1.6 Hardware Optimization

Central focus of the hardware optimization effort was fixed on the Atmospheric Modeling and Simulation System (AMASS), which is based on a Concurrent 3260 MPS processor. The initial configuration of this system is shown in Figure 2.

Numerous modifications were made to the system during 1985-86. The FPS AP-120B array processor was removed from the system after the CRAY became available for vectorized high-speed processing and many numerical models were gradually converted to execute on the CRAY. Storage was increased from 8 MB to 16 MB of four-way interleaved memory. A second tape drive was added to permit convenient tape-to-tape copy operations.

To facilitate a growing number of computationally intensive tasks on the AMASS, it was upgraded to have an additional auxiliary processing unit (APU) as well as an APU/Input-Output Processor (APU/IOP). This permitted concurrent

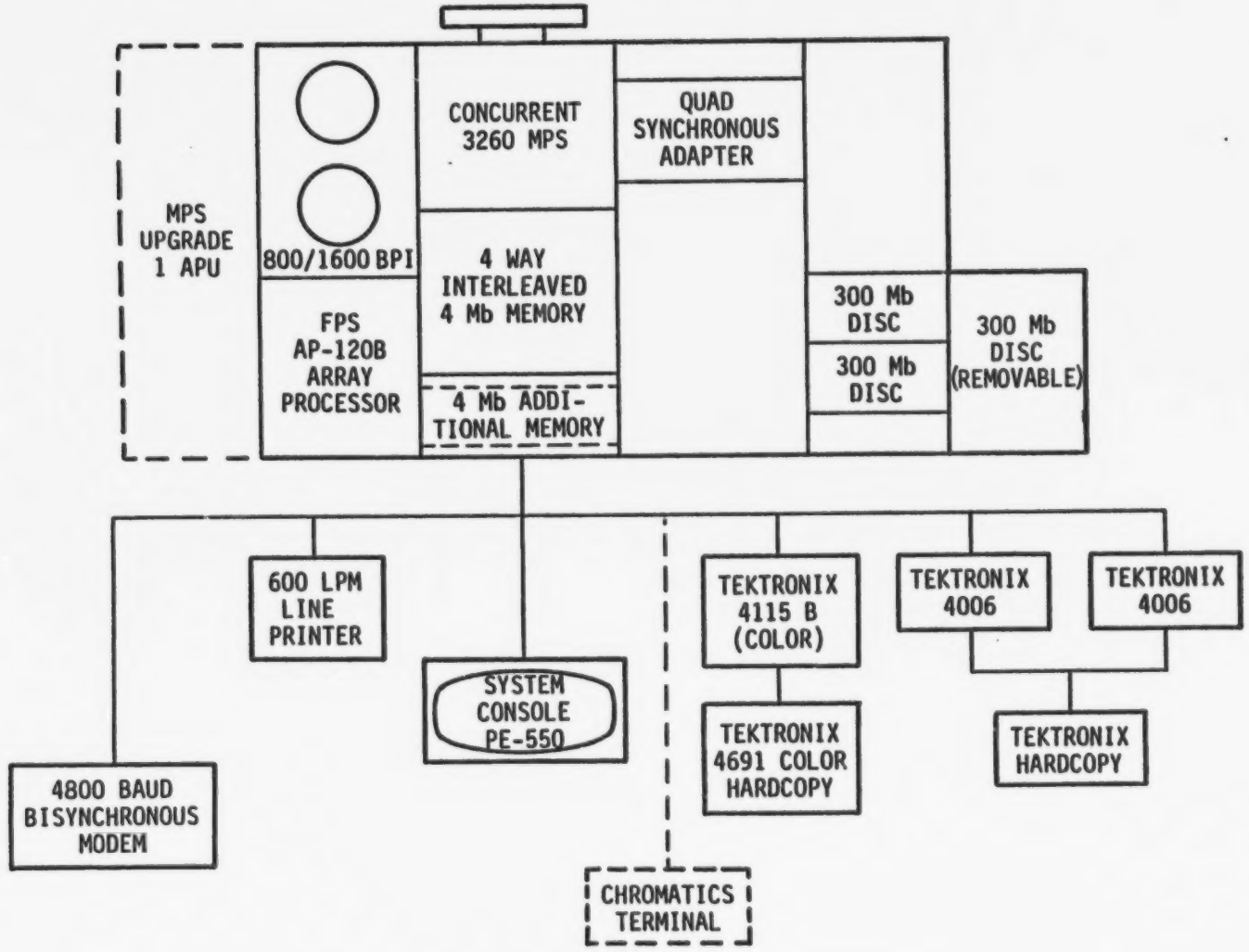

Figure 2. Hardware Configuration in January 1985

execution of up to three jobs (using the CPU and two APU's). The APU/IOP is configurable as either an APU or an IOP, depending on system requirements.

As for terminals, one of the Tektronix 4006 units was removed after it malfunctioned and it was determined that the repair cost would almost equal the purchase cost since it was obtained as a used model at substantial discount. The Concurrent system is connected to the MSFC/LAN using a BIU link. This permits users to access the system as well as EADS in a convenient manner. The current configuration of the AMASS is depicted in Figure 3.

1.7 UNIX/Other Languages

The growing popularity of commercially available workstations which offer very respectable processing speed as well as advanced image processing capabilities has fostered a desire to evaluate the possibility of transferring McIDAS software to these machines. They are, however, primarily UNIX-based systems. This presents a problem since McIDAS is dependent on the IBM MVS environment. Upon evaluation of the problem, it appeared that a reasonable approach was to attempt a prototype workstation emulator with an initial subset of McIDAS commands. Results could then be evaluated and the repertoire expanded as appropriate.

An additional potential benefit of converting McIDAS to operate in a UNIX environment was that numerical models running on the CRAY under UNICOS could call McIDAS routines directly, particularly for display of results.

1.8 High-Speed RJE Link

In 1984, when the proposal was originally submitted, a 4800-baud remote job entry (RJE) interface connected the Perkin-Elmer system to the Goddard Space Flight Center (MSFC) high-speed CYBER 205 computing facility. This RJE facility was used primarily to execute computationally intensive numerical models, such as the South Dakota Cloud Model, which were submitted via the Perkin-Elmer. At that time, it seemed very desirable to upgrade to a faster line to enhance file transfer speed. However, in late 1985, the EADS was installed at MSFC. This system provided a CRAY supercomputer with IBM 3084 front-end processors and an IBM 4381 support processor. Since a supercomputer was available locally by direct connection, it was not necessary to continue to use the Cyber System at GSFC remotely.

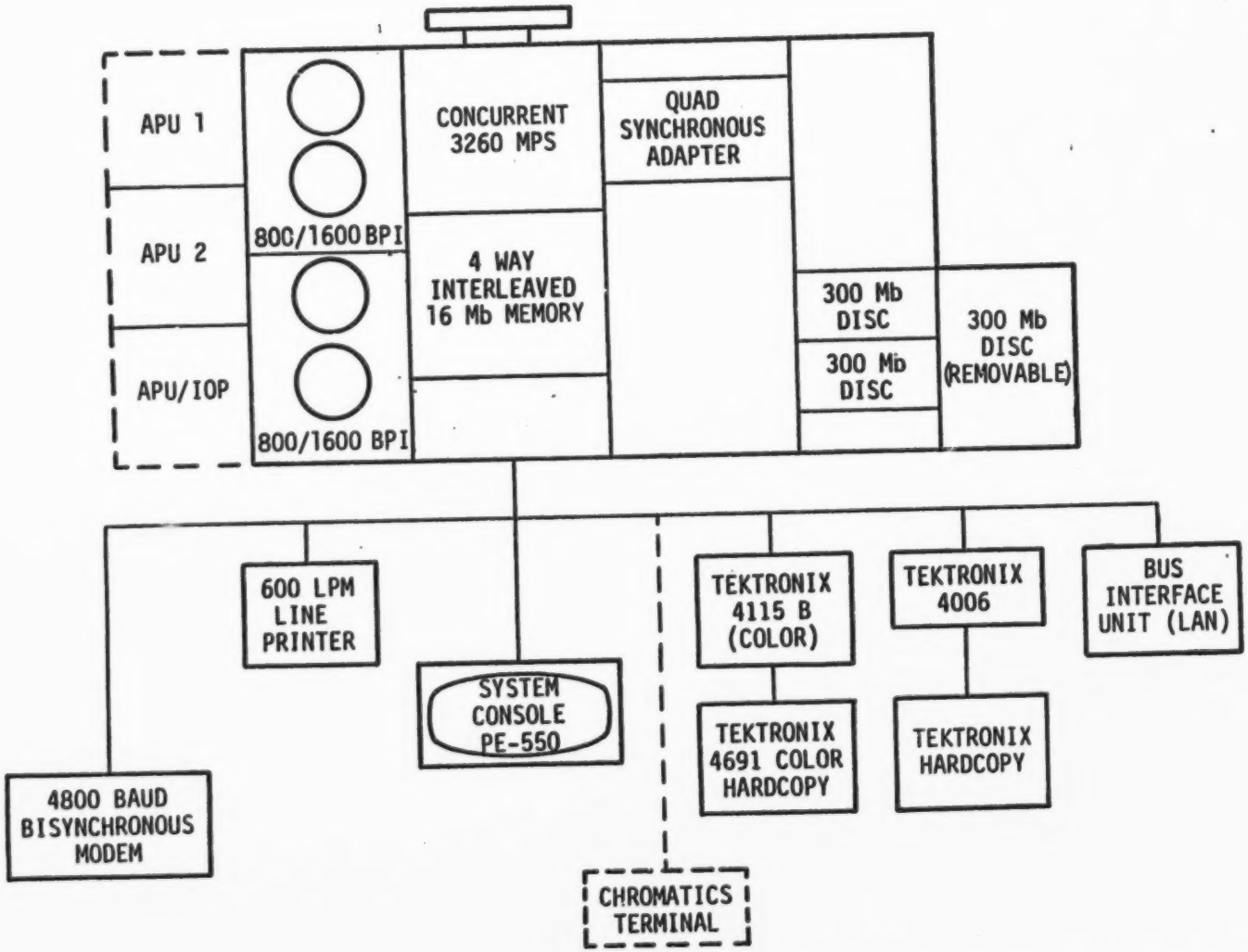

Figure 3. Hardware Configuration at Completion of Contract

1.9 EADS/4381 McIDAS

The initial portion of the EADS system was installed by Grumman Data Systems (GDS) during the summer of 1985. Primary components of the system included an IBM 3084 front-end processor and an IBM 4381 support processor, which served as a common output subsystem. A CRAY X-MP followed a few months later. The current configuration is depicted in Figure 4.

McIDAS was installed on the IBM 4381 system during August 1985. The configuration of this portion of the EADS system evolved over time to become that shown in Figure 5. This system differed substantially from other McIDAS installations in several respects. First, no other installation had access to a supercomputer. This permitted scientists to perform numerical modeling on the CRAY, dispose results to the IBM, convert these data to McIDAS format, then display it on McIDAS.

Another distinguishing feature of this system was that McIDAS had access to a MASSTOR M860 device with 165 Gb storage for general users and 55 Gb storage dedicated to the Earth Science and Applications Divisions. The M860 operates as a collection of cartridges, with each containing approximately 175 Mb of data. The 55 Gb dedicated portion contains 315 of these cartridges. Since each cartridge is treated by the IBM as a magnetic tape, it is possible to set up JCL which causes software to read directly from the MASSTOR cartridge by providing pointer information to the cartridge number and relative position of the selected file on that cartridge. This directory information is readily available to users through the panels of ISPF or background job submission of a catalog inquiry request.

1.10 CRAY/LAN

The CRAY supercomputer component of EADS was installed at MSFC in early 1986. A study was performed to determine the possibility of converting a subset of McIDAS software to execute on the CRAY. This evaluation involved examination of the IBM code as well as discussing the approach with software development and systems personnel at SSEC. It was estimated that this task would probably require two to three years to complete, due primarily to the current integration and the dependency of the McIDAS code to the IBM system software components. This conversion could, however, permit substantial execution speed performance improvements by running on the CRAY.

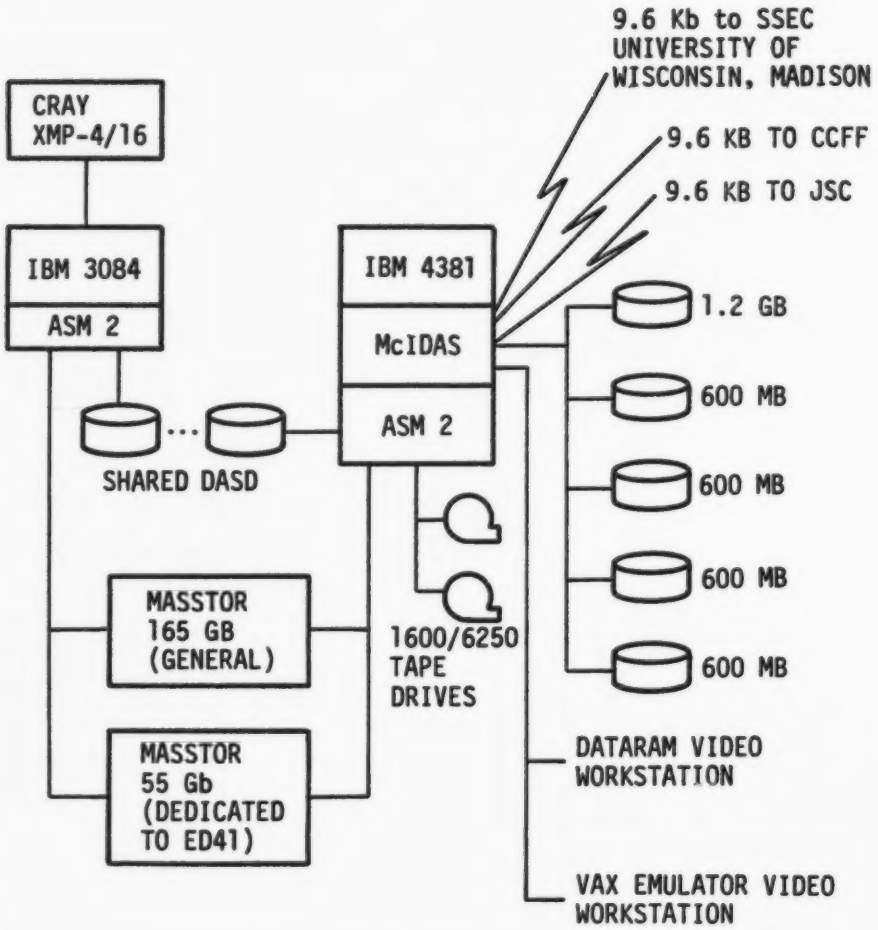

Figure 4. MSFC McIDAS Configuration

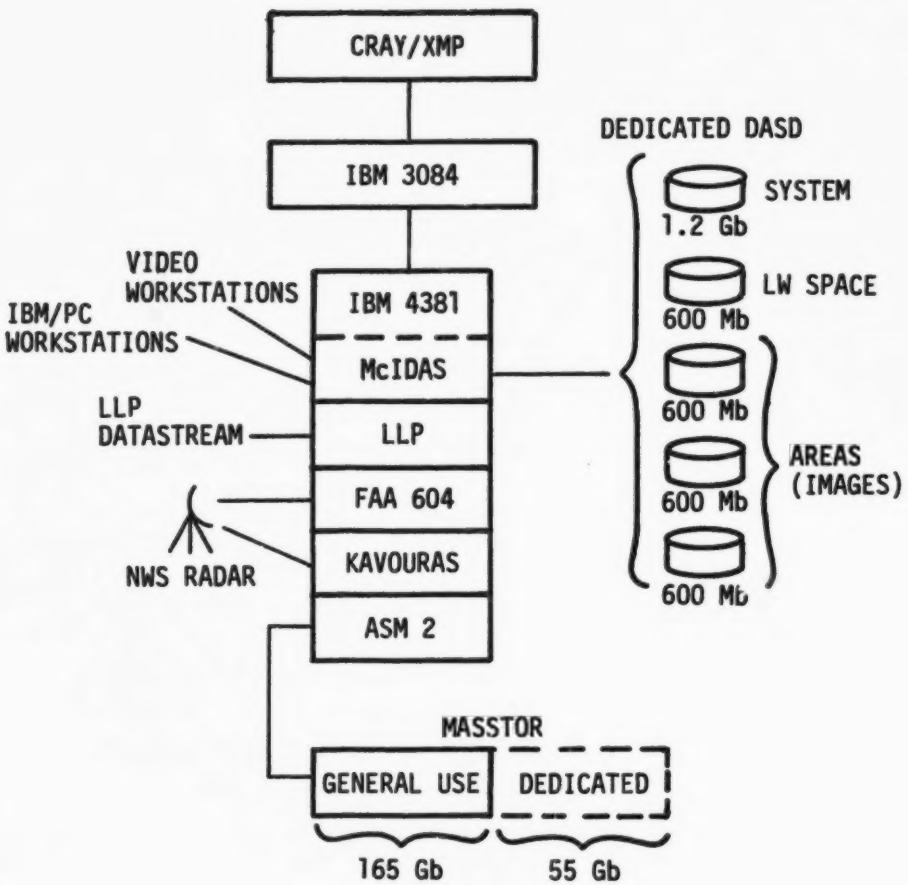

Figure 5. MSFC McIDAS Configuration

The Local Area Network (LAN) provides the supportive communications structure for the EADS network. It is based on the Network Systems Corporation (NSC) Hyperbus product. The LAN was installed during late summer 1985 and experienced significant downtime during the initial utilization period. Originally the FAA 604 data stream and Lightning Location and Protection (LLP) lines were connected via BIU's to the LAN and thus to the IBM 4381 system on EADS, which hosts the ingestor/decoder software. In 1985 when the Kavouras radar acquisition system was installed, it was also interfaced to the LAN. This was the configuration used to support the 1986 COHMEX. Numerous problems were encountered with this arrangement. Primarily, since one of the main reasons for the project was to collect data regarding thunderstorm and microburst development, the weather conditions of interest usually caused power fluctuations or outages to occur. This in turn broke connections in the network and therefore caused an interruption in the data stream. For this reason, the BIU connection between the IBM 3708 communications adapter and the IBM 3725 communications controller (at the host) was replaced by CODEX modems. This has proven to be a vast improvement.

1.11 MAMS Requirements

Some image processing algorithms were implemented and tested on the McIDAS system. Two of primary interest included an edge preserving filter and a bicubic interpolation filter, which provides blowup capability for images while retaining good quality of the image with minimal blurring. These algorithms are useful in processing test data derived from test flights of the Multispectral Atmospheric Mapper Sensor.

1.12 Travel

The following trips were required for the purposes listed:

Destination	Duration	Purpose
Space Science and Engineering Center; University of Wisconsin	3.5 days	McIDAS Meetings and Documentation Review
Johnson Space Center; Houston, TX	2 days	Toured Facility and Attended MIDDS Meetings
Patrick Air Force Base; Cocoa Beach, FL	2 days	Wind Profiler Meetings
Atlanta, GA	1 day	Attended COMDEX/Spring 88

Destination	Duration	Purpose
New Orleans, LA	5 days	AMS Conference and McIDAS Meetings (January 1987)
Tokyo, Japan	12 days	EOS International Coordination Working Group - Discussed opportunities to place laser atmospheric wind sounder (LAWS) instrument on Japanese polar orbiter and attended International Symposium on Tropical Precipitation Measurements
Space Science and Engineering Center; University of Wisconsin	2 days	Attended First International McIDAS User's Meeting
Patrick Air Force Base; Cocoa Beach, FL	2 days	Meeting with MIDDS personnel to discuss MIDDS network
Anaheim, CA	6 days	AMS Conference and McIDAS Meetings (January 1988)
Johnson Space Center; Houston, TX	2 days	Installed and checked out PC-based McIDAS system
NASA Headquarters; Washington, D.C.	2 days	Attended MIDDS Configuration Management Meetings
San Diego, CA	5 days	Attended Perkin-Elmer User's Group Conference (INTERCHANGE)

1.13 Publications

The following three papers were published during the contract.